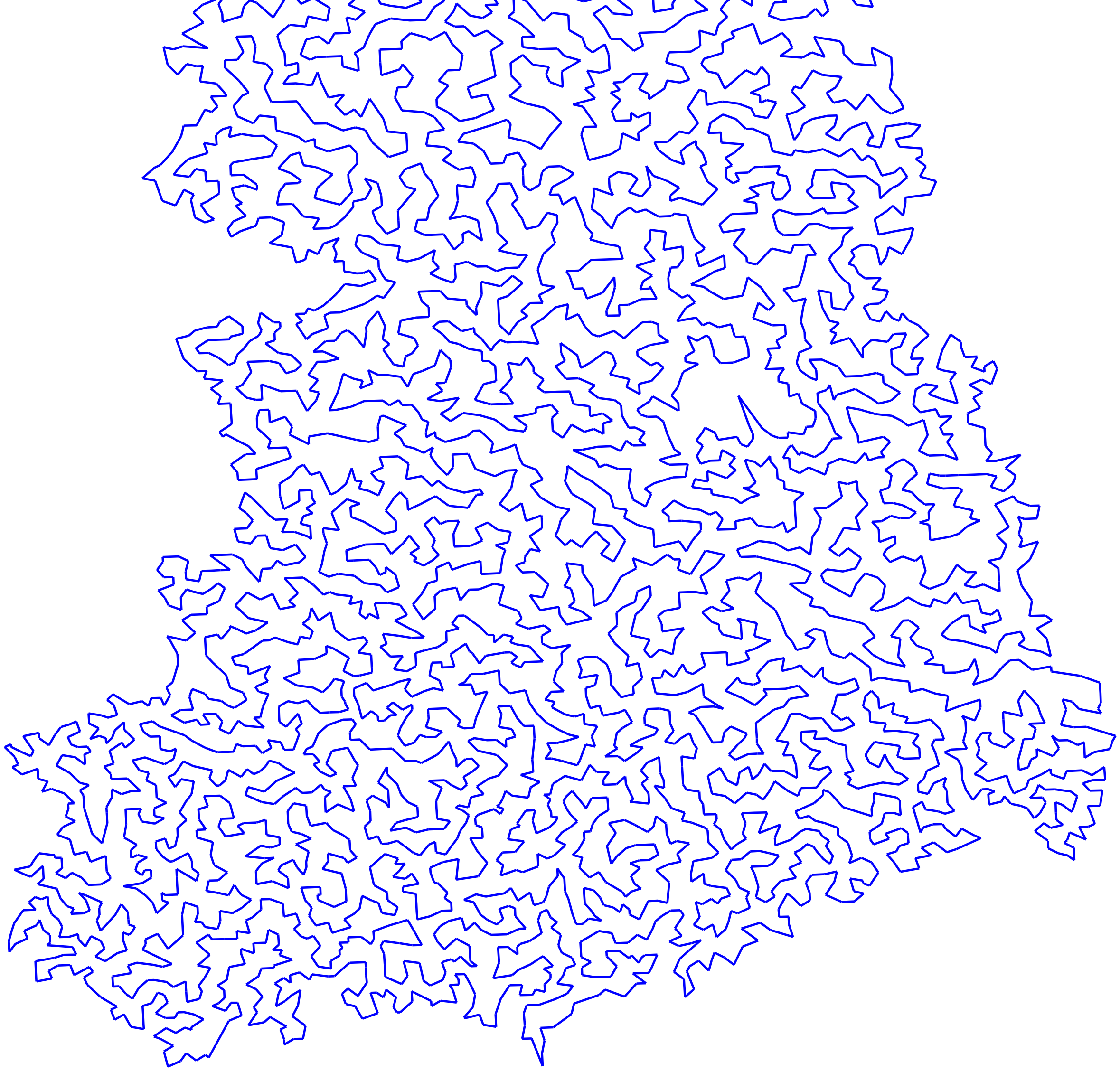
Solving
Travelling Salesman Problems
in Parallel

David Applegate (Rice, CRPC)
Robert Bixby (Rice, CRPC)
Vašek Chvátal (Rutgers)
William Cook (Rice, CRPC)



Why solve TSPs?

- Applications?

- Intuitive

- Hard

- Historic

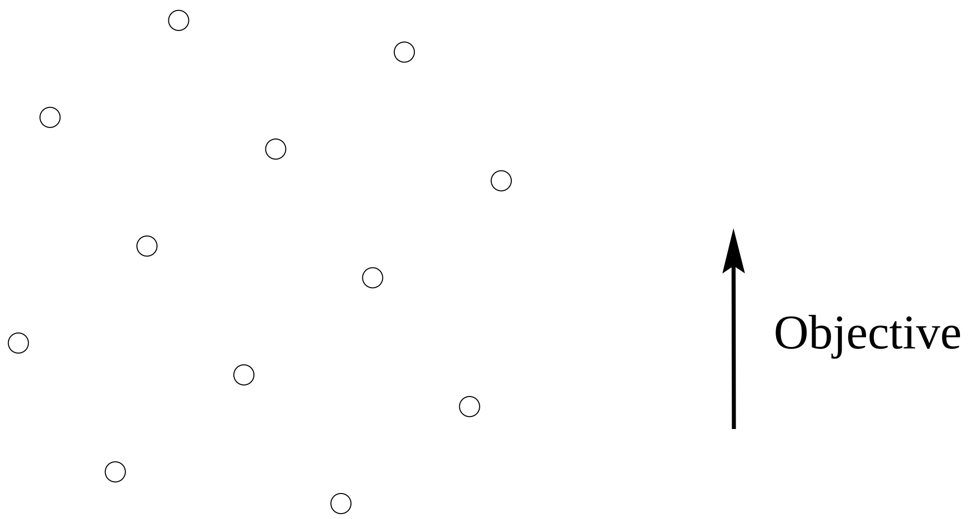
- Well-studied

- Canonical Combinatorial Optimization Problem

How to solve TSPs?

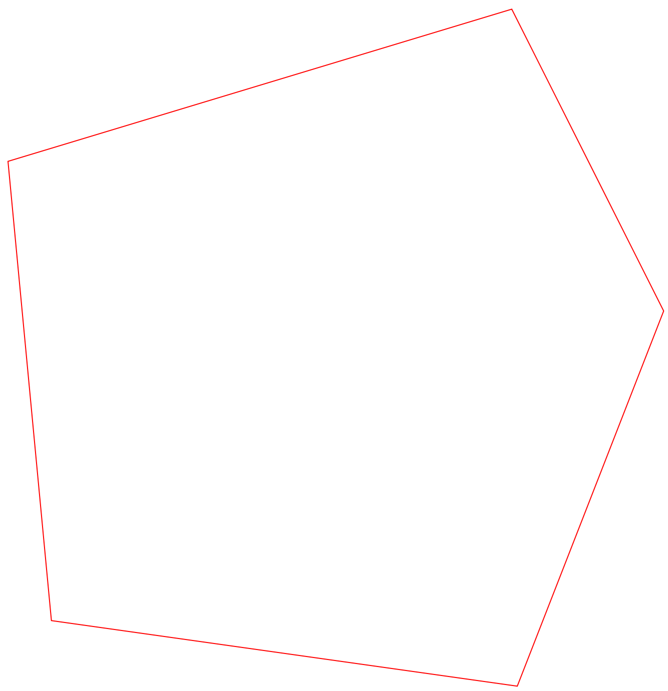
Integer Program

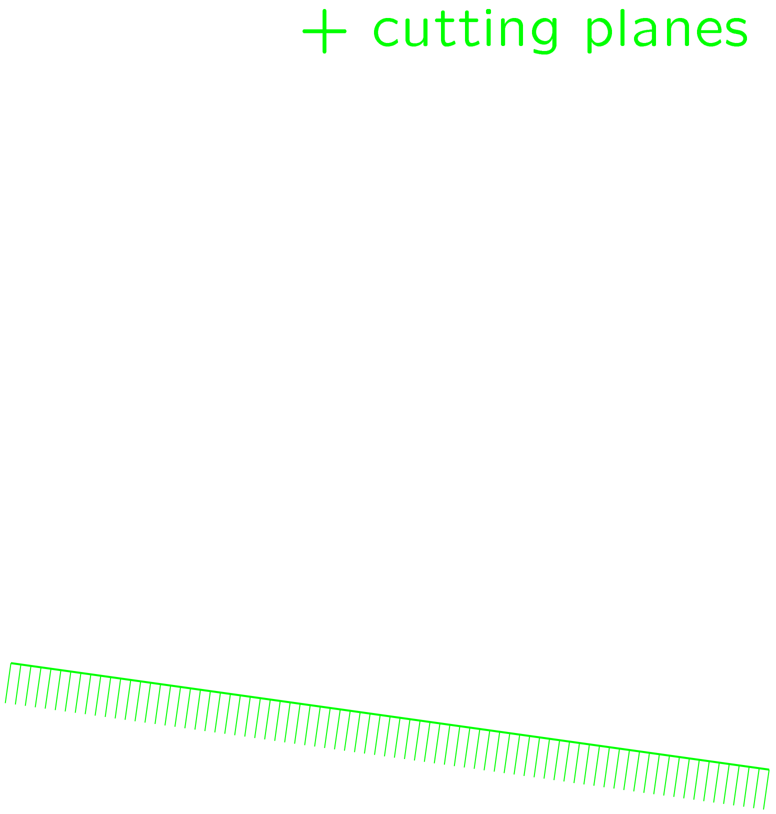
$$
\begin{array}{rrcll}
\max & \displaystyle\sum_{e\in E} c_e x_e & & & \\
\text{subject to:} & & & & \\
 & x_e & \in & \{0,1\} & \forall e \in E \\
 & \displaystyle\sum_{e\in\delta(i)} x_e & = & 2 & \forall i \in V \\
 & \displaystyle\sum_{e\in\delta(S)} x_e & \geq & 2 & \forall S \neq \emptyset \subset V
\end{array}
$$



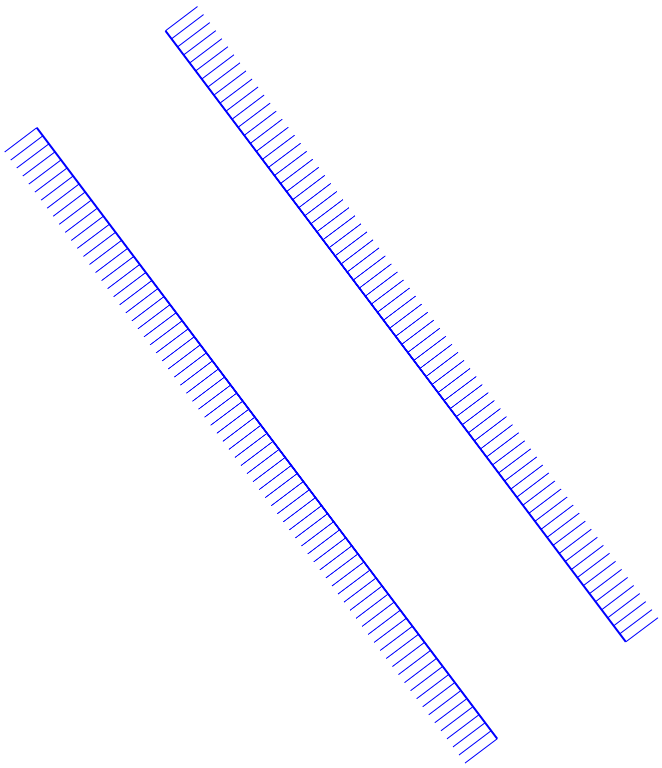
Linear Program

$$x_e \in [0,1] \quad \forall e \in E$$




+ cutting planes

+ branching



Solving in parallel

- Branching nodes independent $\Rightarrow$ Limited communication
- Branching nodes hard $\Rightarrow$ Very course-grained
- Cutting planes shared $\Rightarrow$ Potential bottle-neck

Results

TSPLIB Problem	Cities	Branch Nodes	Time (cpu yr)	CPU
pcb3038	3038	287	≈ 1.5	Sparc 2
fnl4461	4461	2092	≈ 1.9	Sparc 10/30
pla7397	7397	2247	≈ 4	Sparc 10/30
pla7397	7397	2247	≈ 2.5	SGI R4400